LTC1563-2 and LTC1563-3
Fourth Order Active RC Filter ICs

DESCRIPTION

Demonstration circuit DC338B-A is for the evaluation of filter circuits using an LTC®1563-2 and DC338B-B for an LTC1563-3. LTC1563-2 and LTC1563-3 are dual 2nd order active RC filter building blocks with precision ±1.5% capacitors. The LTC1563-2 uses six equal value resistors to implement a 4th order Butterworth lowpass filter, and the LTC1563-3 uses six equal value resistors to implement a 4th order Bessel lowpass filter. The lowpass cutoff frequency (f_C) range of an LTC1563-X filter is 256Hz to 256kHz.

For testing and evaluation, the DC338B-A is configured as a single 4th order, 25.6kHz Butterworth lowpass filter; and the DC338B-B is configured as a single 4th order, 25.6kHz Bessel lowpass filter.

For other LTC1563-X configurations, the DC338B has unused pads for 0805 surface mount resistors and capacitors preconfigured with PCB traces to allow for the following LTC1563-X filter circuits:

1. 4th order lowpass filter
2. 5th order lowpass filter
3. 4th order narrow bandpass filter
4. 4th order wide bandpass filter

Refer to the LT1563-X data sheet for additional information about filter circuit configurations.

Design files for this circuit board are available at http://www.linear.com/demo/DC338B

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are T_A = 25°C

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Total Supply Voltage		●	2.7		11	V
Supply Current	V_S = 2.7V, LP MODE	●		1	1.8	mA
	V_S = ±5V, HS MODE	●		15	23	mA
Lowpass Cutoff Frequency Range	LP MODE		0.256		25.6	kHz
Lowpass Cutoff Frequency Range	HS MODE		0.256		256	kHz
Bandpass Center Frequency Range	LP MODE		0.4		10	kHz
Bandpass Center Frequency Range	HS MODE		0.4		50	kHz
Output Voltage High, LPA and LPB	R_L = 10k			$V^+ - 50mV$		V
Output Voltage Low, LPA and LPB	R_L = 10k			$V^- + 50mV$		V
DC Voltage Offset	V_S = 2.7V, LP MODE	●			6±	mV
	V_S = ±5V, HS MODE	●			3±	mV
LTC1563-X OP AMP GBW	V_S = 2.7V, LP MODE			1.5		MHz
	V_S = 4.75V, LP MODE			1.8		MHz
	V_S = 2.7V, HS MODE			8		MHz
	V_S = 4.75V, HS MODE			9		MHz
	V_S = ±5V, HS MODE			11		MHz

DEMO MANUAL DC338B

LTC1563-X BLOCK DIAGRAM
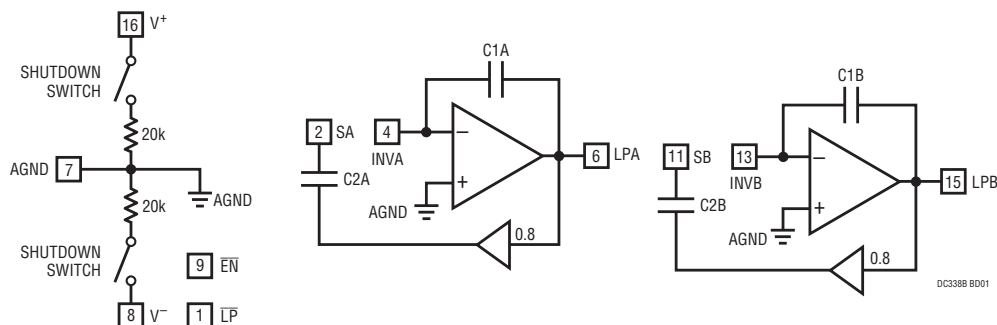
Capacitor Values:

LTC1563-2, SIDE A C1A = 53.8pF, C2A = 64.2pF. SIDE B C1B = 39.1pF, C2B = 87.9pF.

LTC1563-3, SIDE A C1A = 34.9pF, C2A = 38.8pF. SIDE B C1B = 26.8pF, C2B = 40.3pF.

Typical Capacitor Specifications:

Side A to Side B capacitor mismatch ±1.5%, part to part capacitor variation ±2%. Note: There is a stray 5pF capacitor from SA and SB node to ground.

LTC1563-X 4TH ORDER LOWPASS FILTER
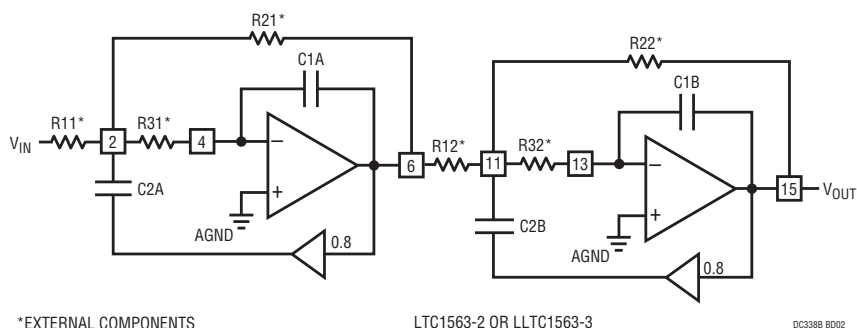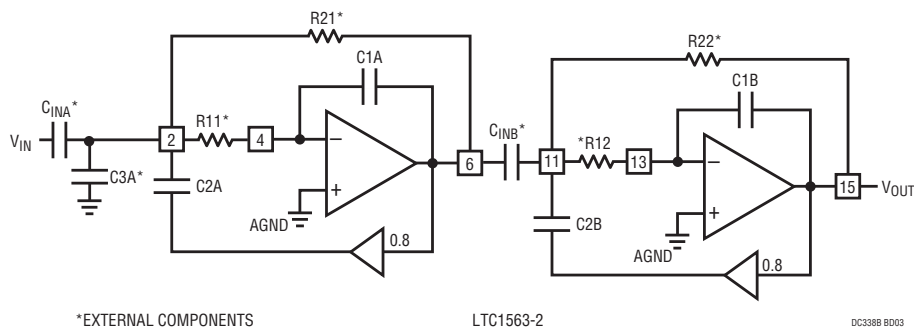

*EXTERNAL COMPONENTS   LTC1563-2 OR LLTC1563-3

LTC1563-X 4TH ORDER BANDPASS FILTER (NARROW PASSBAND)

*EXTERNAL COMPONENTS   LTC1563-2

QUICK START PROCEDURE

See Figure 1 for proper measurement equipment setup and follow the procedure below.

1. Place jumpers in the following positions: JP4 to DUAL SUPPLY, JP3 to ACTIVE, JP5 to HIGH SPEED.

2. With power off, connect a dual 5V power supply to +V and –V.

3. Connect a 10kHz, 1V$_{P-P}$, sine wave generator to V$_{IN}$ and GND turrets.

4. Set the scaling of an oscilloscope to 1V/100µs per division.

5. Connect an oscilloscope probe from V$_{OUT}$ and GND to oscilloscope channel 1.

6. Power up the system and the oscilloscope should show a 10kHz 1V$_{P-P}$ sine wave.

7. To test stopband attenuation, set the input frequency to 100kHz and the output voltage drops to less than 5mV$_{P-P}$ and 25mV for the DC338B-A and DC338B-B, respectively.
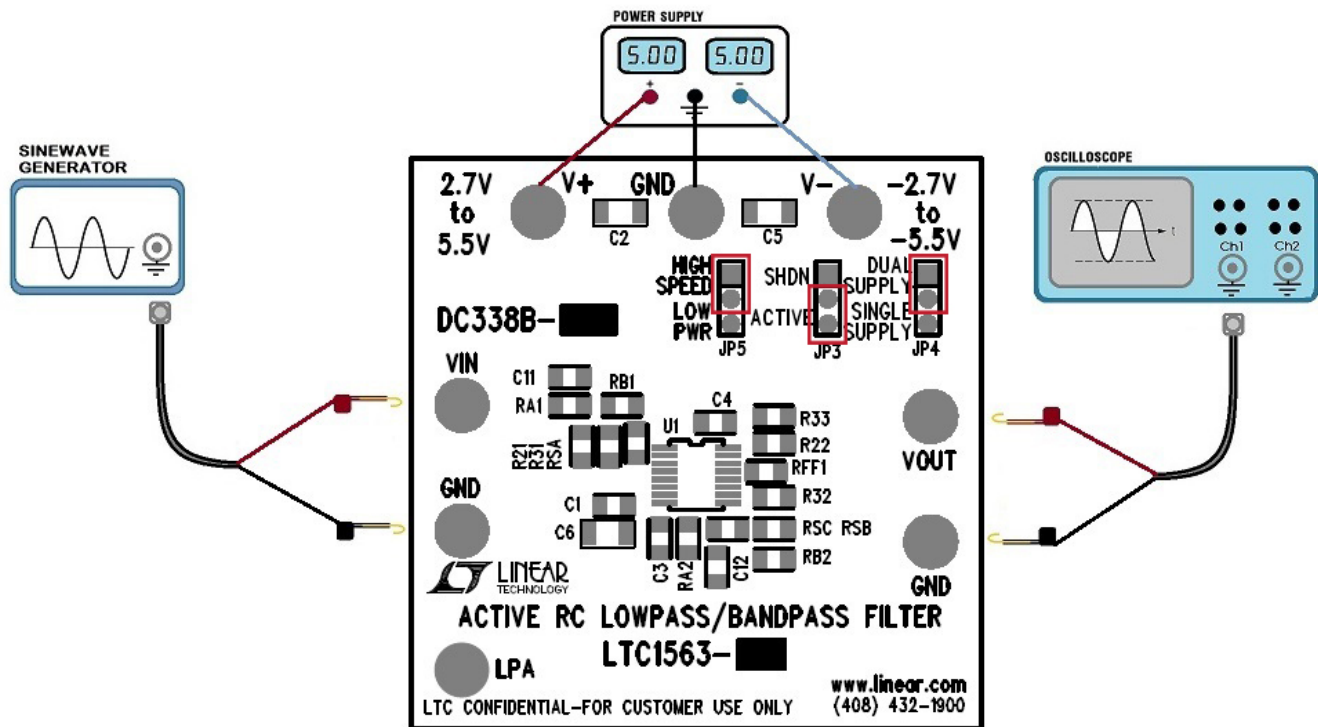

Figure 1. Quick Start Test Equipment Setup

QUICK START PROCEDURE

DC338B Default Configuration

For testing and evaluation, the DC338B-A is configured as a single 4th order, 25.6kHz Butterworth lowpass filter (the Figure 2 circuit) and the DC338B-B is configured as a single 4th order, 25.6kHz Bessel lowpass filter (the Figure 3 circuit).

Reconfiguring the DC338B

Removing the default passive components (RA1, RB1 RSA, R31, R21, RA2, RB2 RSB, R32 and R22), the DC338B can be configured for variety of lowpass or bandpass filter circuits. Figures 2 thru 6 highlight easy to design and simulate with LTspice[1] LTC1563 filter circuits.

Note: The LTC1563-X LTspice models only, the high speed mode (HP) with op amps at the maximum GBW (listed under Electrical Characteristics). The GBW limit must be considered when simulating LTspice circuits. For example, if an LTC1563 circuit operates in low power mode then the maximum lowpass cutoff frequency is 25.6kHz and an LTspice simulation showing a typical frequency response at cutoff frequencies greater than 25.6kHz is overly optimistic.

[1]LTspice is a high performance simulator, schematic capture and waveform viewer available for free download at www.linear.com/LTspice.

QUICK START PROCEDURE

RA2 ON DC338B
MUST BE 0Ω

V^+ 0.1μF

RA1 ON DC338B
MUST BE 0Ω

RB1
(2.56G/f_C)

RSA ON DC338B
MUST BE 0Ω

V_{IN}

V1
AC 1
2.5

R31
(2.56G/f_C)

R21
(2.56G/f_C)

0.1μF

.PARAM f_C = 10k
.AC OCT 100 1k 100k

$V+$

V2
5

$\overline{LP}$ U1 V^+

SA LPB

LT

INVA INVB

LPA SB

AGND LTC1563-2

V^- $\overline{EN}$

R22
(2.56G/f_C)

RB2
(2.56G/f_C)

R32
(2.56G/f_C)

RSB ON DC338B
MUST BE 0Ω

V_{OUT}

DC338B F02a

4TH ORDER BUTTERWORTH LOWPASS FILTER
MAXIMUM f_C IS:
25.6kHz FOR LOW POWER AND
256kHz FOR HIGH SPEED
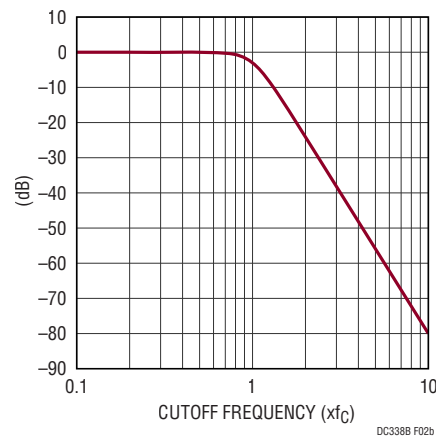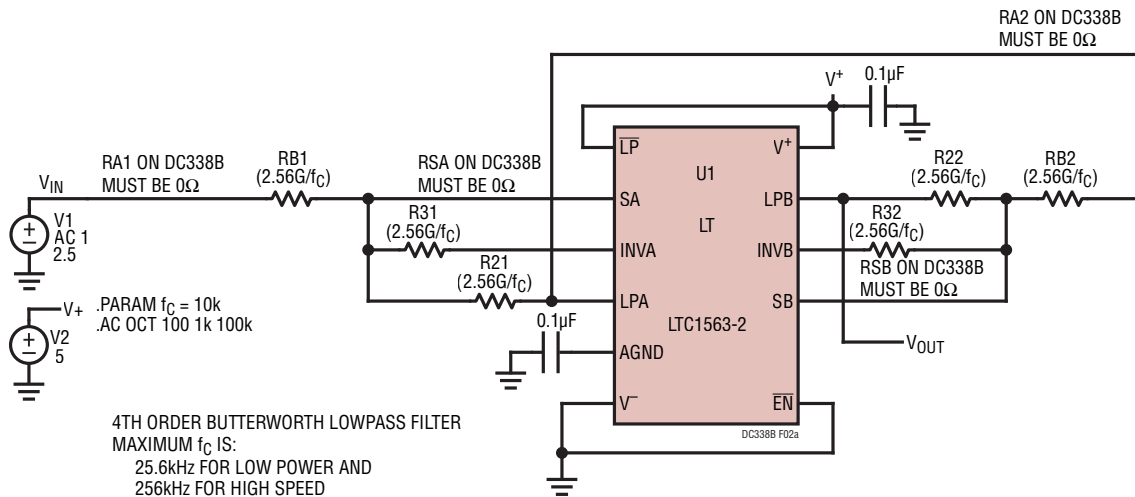

CUTOFF FREQUENCY (xf_C)

(dB)

DC338B F02b

Figure 2. 4th Order Butterworth Lowpass Filter (DC338A-A Default Configuration)

The LTspice file for this circuit is available at www.linear.com/demo/DC338B.

QUICK START PROCEDURE

RA2 ON DC338B
MUST BE 0Ω

V⁺ 0.1µF

$\overline{LP}$ U1 V⁺
SA LPB
INVA LT INVB
LPA SB
AGND LTC1563-3
V⁻ $\overline{EN}$

DC338B F03a

V_IN
RA1 ON DC338B
MUST BE 0Ω
RB1 (2.56G/f_C)
RSA ON DC338B MUST BE 0Ω
R22 (2.56G/f_C)
RB2 (2.56G/f_C)
R31 (2.56G/f_C)
R32 (2.56G/f_C)
R21 (2.56G/f_C)
RSB ON DC338B MUST BE 0Ω

V1
AC 1
2.5

0.1µF

V_OUT

V+
V2
5

.PARAM f_C = 10k
.AC OCT 100 1k 100k

4TH ORDER BESSEL LOWPASS FILTER
MAXIMUM f_C IS:
    25.6kHz FOR LOW POWER AND
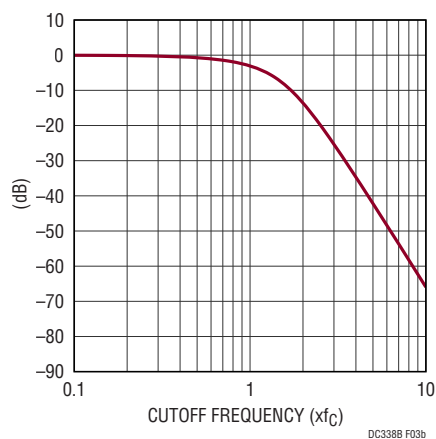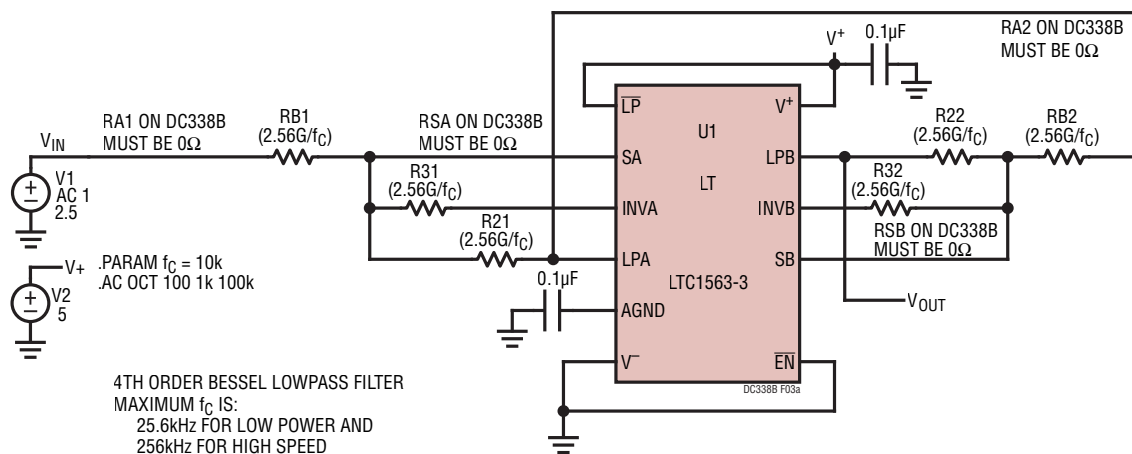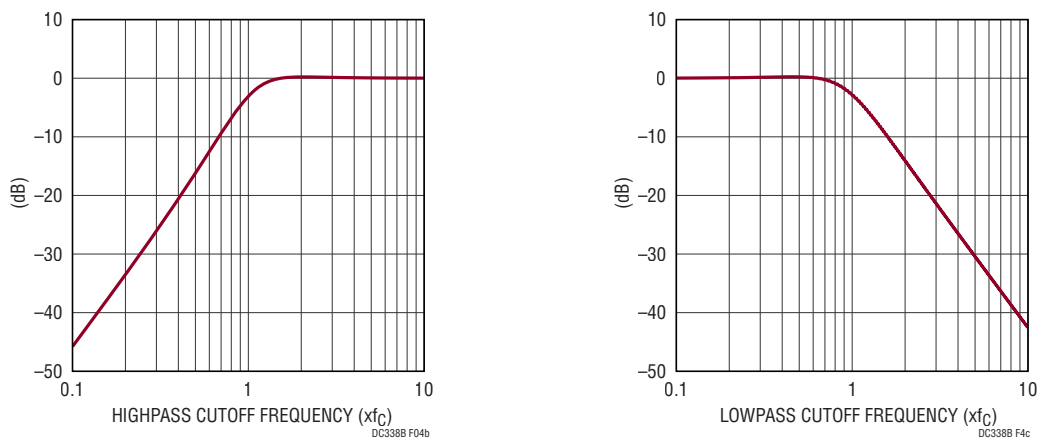   256kHz FOR HIGH SPEED

Figure 3. 4th Order Bessel Lowpass Filter (DC338A-B Default Configuration)

The LTspice file for this circuit is available at www.linear.com/demo/DC338B.

QUICK START PROCEDURE

RA1 [$f_{CLP}/(21.2G \cdot f_{CHP})$]

RB1 ($2.91G/f_{CLP}$)

RSA ($2.91G/f_{CLP}$)

R31 ON DC338B MUST BE 0Ω

R21 ($2.91G/f_{CLP}$)

V_{IN}

V1 AC 1

V2 5

V+

0.1µF

U2

LT

LTC1563-2

$\overline{LP}$ V+

SA LPB

INVA INVB

LPA SB

AGND

V− $\overline{EN}$

0.1µF

R22 ($2.4G/f_{CHP}$)

R32 ON DC338B MUST BE 0Ω

RB2 39pF

RA2 ($5.62G/f_{CLP}$)

RSB ($2.4G/f_{CHP}$)

V_{OUT}

.PARAM f_{CHP} = 1k
.PARAM f_{CLP} = 10k
.AC OCT 100 100 100k

WIDE BANDPASS
−3dB BW FROM f_{CHP} TO f_{CLP}
$f_{CLP} \geq 2.5 \times f_{CHP}$
MINIMUM f_{CHP} = 240Hz,
MAXIMUM f_{CLP}:
  20kHz FOR LOW POWER AND
  200kHz FOR HIGH SPEED

DC338B F04a

HIGHPASS CUTOFF FREQUENCY (xf_C)
DC338B F04b

LOWPASS CUTOFF FREQUENCY (xf_C)
DC338B F4c

Figure 4. 4th Order Wide Bandpass Filter

The LTspice file for this circuit is available at www.linear.com/demo/DC338B.

QUICK START PROCEDURE

Figure 5. 4th Order Narrow Bandpass Filter

The LTspice file for this circuit is available at www.linear.com/demo/DC338B.

QUICK START PROCEDURE

RSA ON DC338B
MUST BE 0Ω

RSB ON DC338B
MUST BE 0Ω

RB1 ON DC338B
MUST BE 0Ω

RA1
100pF

V_{IN}

V1
AC 1

C11
1nF

V+
V2
5

.PARAM f_C = 10k
.AC OCT 100 1k 100k

R31
(649MEG/f_C)

R21
(750MEG/f_C)

U2
LT
LTC1563-2

$\overline{LP}$
SA
INVA
LPA
AGND
V⁻

V⁺
LPB
INVB
SB
$\overline{EN}$

0.1µF

0.1µF

R22
(1.43G/f_C)

R32
(1.91G/f_C)

RB2
100pF

RA2
(49.9G/f_C)

V_{OUT}

DC338B F06a

BANDPASS FILTER
−1dB PASSBAND = 0.2× f_C
GAIN AT f_C = 14dB
f_C RANGE:
LP MODE 400Hz – 10kHz
HS MODE 400Hz – 40kHz

Figure 6. 4th Order Narrow Bandpass Filter with 14dB Gain
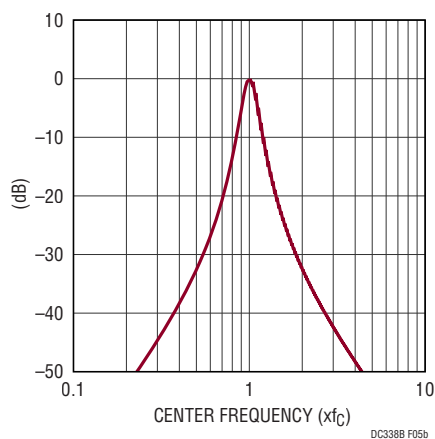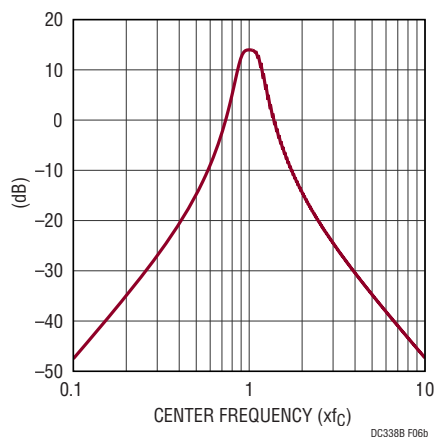
The LTspice file for this circuit is available at www.linear.com/demo/DC338B.

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